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PATENT

Attorney's Docket No. 21,669 USA

Commissioner of Patents
and Trademarks
Washington, DC 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of
Inventor(s):Kim A. Reynolds et al.

WARNING: Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b).

For (title):**ABRASION RESISTANT MULTI-WALL ARTICLE AND METHOD OF MAKING SAME**

1. Type of Application

This new application is for a(n) (*check one applicable item below*):

__x__ Original

_____ Design

_____ Plant

WARNING: Do not use this transmittal for a completion in the U.S. of an International Application under 35 USC 371(c)(4) unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

NOTE: If one of the following 3 items apply then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED.

_____ Divisional

_____ Continuation

_____ Continuation-in-part (CIP)

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this New Application Transmittal and the documents referred to as enclosed therein are being deposited with the United States Postal Service on this date April 24, 1998 in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL054822092US addressed to the: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

Patricia M. Frisoli
(Type or print name of person mailing paper)

Patricia M. Frisoli
(Signature of person mailing paper)

NOTE: Each paper or fee referred to as enclosed herein has the number of the "Express Mail" mailing label placed thereon prior to mailing 37 CFR 1.10(b).

2. Benefit of Prior U.S. Application(s) (35 USC 120)

NOTE: If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

_____ The new application being transmitted claims the benefit of prior U.S. application(s) and enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF U.S. APPLICATION(S) CLAIMED.

3. Papers Enclosed Which Are Required For Filing Date Under 37 CFR 1.53(b) (Regular) or 37 CFR 1.153 (Design) Application

16 Pages of specification

5 Pages of claims

1 Pages of Abstract

0 Sheets of drawing

_____ formal

_____ informal

WARNING: DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. **Only one copy is required or desired.** Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).

NOTE: "Identifying indicia such as the serial number, group and unit, title of the invention, attorney's docket number, inventor's name, number of sheets, etc., not to exceed 2-3/4 inches (7.0 cm.) in width may be placed in a centered location between the side edges within three fourths inch (19.1 mm.) of the top edge. Either this marking technique on the front of the drawing or the placement, although not preferred, of this information and the title of the invention on the back of the drawings is acceptable." Proposed 37 CFR 1.84(1). Notice of March 9, 1988 (1090 O.G. 57-62).

4. Additional papers enclosed

_____ Preliminary Amendment

_____ Information Disclosure Statement

_____ Form PTO-1449

_____ Citations

_____ Declaration of Biological Deposit

_____ Authorization of Attorney(s) to Accept and Follow Instructions from Representative

_____ Special Comments

_____ Other

5. Declaration or oath

__X__ Enclosed

executed by (*check all applicable boxes*)

__X__ inventor(s).

_____ legal representative of inventor(s). 37 CFR 1.42 or 1.43

_____ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

_____ this is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. *See item 13 below for fee.*

_____ Not Enclosed.

WARNING: Where the filing is a completion in the U.S. of an International Application but where a declaration is not available or where the completion of the U.S. application contains subject matter in addition to the International Application the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

_____ Application is made by a person authorized under 37 CFR 1.41(c) on behalf of *all* the above named inventor(s). The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently.

NOTE: It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

_____ Showing that the filing is authorized. (Not required unless called into question. 37 CFR 1.41(d)).

6. Inventorship Statement

WARNING: If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

__X__ The same

or

_____ Are not the same. An explanation, including the ownership of the various claims at the time the **last** claimed invention was made,

_____ is submitted.

_____ will be submitted.

7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of $130.00 required by 37 CFR 1.17(k) is required to be filed with the application or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(d).

__X__ English

_____ non-English

_____ the attached translation is a verified translation. 37 CFR 1.52(d).

8. Assignment

_____ An assignment of the invention to _____

_____

_____ is attached.

_____ will follow.

9. Certified Copy

Certified copy(ies) of application(s)

(country)	(appln. no.)	(filed)
(country)	(appln. no.)	(filed)
(country)	(appln. no.)	(filed)

from which priority is claimed

_____ is(are) attached.

_____ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 USC 120 is itself entitled to priority from a prior foreign application then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

10. Fee Calculation (37 CFR 1.16)

A. _X_ Regular application

CLAIMS AS FILED				
Number filed		Number Extra	Rate	Basic Fee
				$790.00
Total Claims 23	-20=	3	X $22.00	66.00
Independent Claims (37 CFR 1.16(b)) 3	- 3=	0	X $82.00	-0-
Multiple dependent claim(s), if any (37 CFR 1.16(d))			$270.00	

_____ Amendment cancelling extra claims enclosed.

_____ Amendment deleting multiple dependencies enclosed.

_____ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation $ 856.00

B. _____ Design application
($330.00--37 CFR 1.16(f))
Filing Fee Calculation $_____

C. _____ Plant application
($540.00--37 CFR 1.16(g))
Filing Fee Calculation $_____

11. Small Entity Statement(s)

_____ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is(are) attached.

Filing Fee Calculation (50% of **A, B** or **C** above) $_____

NOTE: Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. 37 CFR 1.28(a).

12. Request for International-Type Search (37 CFR 1.104(d))
(complete, if applicable)

_____ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made At This Time

_____ Not Enclosed.

_____ No filing fee is to be paid at this time. (*This and the surcharge required by 37 CFR 1.16(e) can be paid subsequently*).

__X__ Enclosed

__X__	basic filing fee	$ 856.00
_____	recording assignment ($40.00; 37 CFR 1.21(h))	$_____
_____	petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached. ($130.00; 37 CFR 1.47 and 1.17(h))	$_____
_____	for processing an application with a specification in a non-English language. ($130.00; 37 CFR 1.52(d) and 1.17(k))	$_____
_____	processing and retention fee ($130.00; 37 CFR 1.53(d) and 1.21(l))	$_____
_____	fee for international-type search report ($40.00; 37 CFR 1.21(e))	$_____

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U S. application, either the basic filing fee must be paid or the processing and retention fee of § 1.21(l) must be paid within 1 year from notification under § 53(d).

Total fees enclosed **$ 856.00**

14. Method of Payment of Fees

__X__ Check in the amount of $ 856.00

_____ Charge Account No. 19-5425 in the amount of $_____. A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

15. Authorization to Charge Additional Fees

WARNING: If no fees are to be paid on filing the following items should not be completed.

WARNING: Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

__X__ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 19-5425:

__X__ 37 CFR 1.16(a), (f) or (g)(filing fees)

__X__ 37 CFR 1.16(b), (c) and (d)(presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

_____ 37 CFR 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

_____ 37 CFR 1.17 (application processing fees)

WARNING: While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a) this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 CFR 1.136(a) is to no avail unless a request or petition for extension is filed". (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).

_____ 37 CFR 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 CFR 1.31 (b))

NOTE: When an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the Notice of Allowance. 37 CFR 1.311(b).

NOTE: 37 CFR 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application...prior to paying, or at the time of paying...issue fee". From the wording of 37 CFR 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

16. Instructions As To Overpayment

__X__ credit Account No. 19-5425

_____ refund

Reg. No. 40,816

Tel. No. (215) 923-4466

SIGNATURE OF ATTORNEY

Joshua R. Slavitt
Type or print name of attorney

Synnestvedt & Lechner LLP
Name of Firm

1101 Market Street, Suite 2600
P. O. Address

Philadelphia, PA 19107

_____ **Incorporation by reference of added pages**

Check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED

_____ Plus added Pages For New Application Transmittal Where Benefit Of Prior U.S. Application(s) Claimed

Number of pages added _____

_____ Plus Added Pages For Papers Referred To In Item 4 Above

Number of pages added _____

__X__ **Statement Where No Further Pages Added**

(If no further pages form a part of this Transmittal then end this Transmittal with this page and check the following item)

__X__ This transmittal ends with this page.

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ABRASION RESISTANT MULTI-WALL ARTICLE AND METHOD OF MAKING SAME

This invention relates to an abrasion-resistant multi-wall fluorocarbon polymer resin article, such as polytetrafluoroethylene ("PTFE") conduits, having high internal frictional efficiency over wide temperature and load conditions as well as enhanced external crush and creep resistance, and a method of making same. The article of the present invention is particularly well adapted for use in motion transmitting cable assemblies and the like.

Motion transmitting cable assemblies are typically used for the transmission of force and/or motion from one location to another in apparatus such as automobiles, aircraft, marine craft, motorcycles and bicycles. Such cable assemblies, typically comprising a cable for transmitting the appropriate force or motion and a conduit through which the cable is guided, are used in connection with the various critical components of the aforementioned apparatus, such as throttles, clutches and brakes,

as well as a variety of accessories such as air conditioners, heaters, vents, side view mirrors, and the like. It will be understood that as used herein, motion transmitting cable assemblies shall mean extruded and molded tubular products such as push-pull, push-push, pull-pull and rotary cable assemblies and the like, as well as combinations and variations thereof.

Motion transmitting cable assemblies involve a variety of movements of the cable relative to the surrounding conduit including unidirectional, reciprocal, rotary, and combinations of these. Moreover, the movements of the cable relative to the surrounding conduit may range widely in rate, degree and constancy as well as the load under which such movements occur. As a result of these movements, the internal surface of the conduit surrounding the cable is subjected to repeated contact and abrasion by the cable. As used herein, abrasion will refer to the types of damage resulting to the internal surfaces of the articles of the present invention due to the relative movement of cables running therethrough.

It will be appreciated that reliable operation of motion transmitting cable assemblies over extended periods of use is both desirable and critical to the safety of vehicles employing such assemblies. Consequently, in order to achieve superior or even acceptable cable assembly life, conduits have heretofore been constructed with abrasion resistant liners, have employed lubricants and protective outer wrappings or casings, and have utilized combinations of these measures.

Fluorocarbon polymers, such as PTFE resins, are well known in the art and have heretofore been utilized in extruded and molded products such as motion transmitting cable assemblies and the like. In their pure form, PTFE resins exhibit excellent frictional efficiencies. In such form, however, PTFE resins generally exhibit unacceptably low abrasion and creep resistance. As a result, attempts have been made to improve the abrasion and creep resistance of PTFE resins by the addition of organic and inorganic materials as fillers.

It is well known in the art to enhance the abrasion resistance of polymeric products, particularly PTFE extruded products such as conduits, by the inclusion of inert, inorganic fillers such as glass fibers, carbon, asbestos fibers, mica, metals and metal oxides. See, for example, U.S. Pat. No. 3,409,584 - Buschman, et al. While a measure of improvement in abrasion resistance has thus been achieved, applicant has recognized that PTFE composites comprising inorganic fillers have continued to display several disadvantages.

The inclusion of inorganic fillers in PTFE conduits for motion transmitting cable assemblies generally lowers the frictional efficiency of such conduits. Further, such inorganically filled articles tend to exhibit rapid deterioration in frictional efficiency after relatively short periods of use. Moreover, the use of lubricants to counteract the loss of frictional efficiency in such conduits is not generally recommended because the inorganic fillers have been found to separate from the composite matrix and

form an abrasive slurry with the lubricant. This abrasive slurry not only decreases frictional efficiency of the conduit, but also can cause rapid and catastrophic failure thereof. As a practical result, therefore, it has not been heretofore possible to use inorganically filled PTFE composites in motion transmitting cable assemblies and achieve sustainable high frictional efficiencies.

Fluorocarbon polymers have also been modified to include organic fillers. See, for example, U.S. Pat. Nos. 3,652,409 - Mack et al., and 4,362,069 - Giatras et al. Generally, such organic fillers suitable for use in fluorocarbon polymer conduits are expensive and render the resultant article economically disadvantageous. Further, where organically filled fluorocarbon polymer conduits have been used acceptably they have required relatively expensive and cumbersome outer casings, such as lay wires or steel ribbon wrapping helically wound thereabout, in order to protect the abrasion-resistant material incorporated therein.

Due to the limitations found in the prior art, abrasion resistance in motion transmitting cables has heretofore been limited. Applicant has surprisingly and unexpectedly found that a multi-wall conduit comprising at least an inner wall and an outer wall wherein the inner wall comprises PTFE and the outer wall comprises a composition of PTFE and an inorganic filler yields an article which exhibits superior abrasion resistance. In certain preferred embodiments, the inner wall further comprises an organic filler to further enhance abrasion resistance. The articles of the present invention also provide the additional benefits of superior

crush and creep resistance as well. The articles of the present invention are particularly well adapted for use in motion transmitting cable assemblies and the like.

Accordingly, it is an object of the present invention to provide an abrasion resistant multi-wall conduit.

It is another object of the present invention to provide an abrasion resistant multi-wall conduit adapted for use in motion transmitting cable assemblies and the like.

It is yet another object of the present invention to provide an abrasion resistant multi-wall conduit adapted for use in motion transmitting cable assemblies and the like having superior crush and creep resistance.

Still other objects of the invention will be apparent to those of ordinary skill in the art and upon consideration of the following description of the invention.

The present invention relates to abrasion resistant, multi-wall fluorocarbon polymer resin articles having high frictional efficiency over wide temperature and load conditions as well as enhanced crush and creep resistance. The articles of the present invention comprise at least two walls arranged in a coaxial configuration wherein the inner wall comprises a fluorocarbon polymer resin, preferably PTFE, and the outer wall comprises a fluorocarbon polymer resin, preferably PTFE, and an inorganic filler. In certain preferred embodiments, the inner wall component will further comprise an organic filler. The articles of the present invention may further comprise an additional wall, also

arranged coaxially and disposed between the inner and the outer walls, comprising a fluorocarbon polymer resin, preferably PTFE. The multi-wall article as disclosed more fully below is well adapted for use as a conduit in motion transmitting assemblies and the like.

A distinguishing feature of the present invention over the prior art is the employment of multi-wall construction. This multi-wall construction permits realization of a number of advantages including the combination of enhanced abrasion resistance with enhanced crush and creep resistance. Moreover, this combination of properties is realized in the articles of the present invention while avoiding many of the disadvantages found in the prior art as set forth above.

More particularly, by providing a separating layer between the inorganically filled composite comprising the outer wall of a motion transmitting cable assembly conduit and the cable running therethrough, the loss of frictional efficiency as well as the potential for forming an abrasive slurry with the lubricating medium leading to rapid or catastrophic deterioration of the conduit is avoided without the loss of abrasion resistance. By the same token, by surrounding the inner wall with a continuous and relatively hard protective layer, i.e., the inorganically filled outer wall, the abrasion resistance of the inner wall of the resulting article is enhanced and permits for certain applications the utilization of PTFE without the need for abrasion-resistance enhancing fillers as the material comprising the inner wall having

direct contact with the cable running therethrough. Further, by employing an inorganically filled outer wall, the additional benefits of crush and creep resistance are also realized and the use of costly organic filler material can either be significantly reduced or, in certain embodiments, eliminated entirely.

It is important to the present invention that all of the wall components are formed substantially simultaneously. More specifically, independent of the particular process employed in the formation of the multi-wall conduit, it is important that an intimate mechanical bond between adjacent walls of the conduit be established. This bond is most advantageously created through the mechanical interlocking of the particles of the composites comprising the interface between adjacent walls which occurs as the walls are co-extruded or otherwise formed.

In certain preferred embodiments, a paste extrusion process is employed. When such a process is applied to the present invention, it preferably comprises the steps of 1) separately premixing the wall component compositions with predetermined quantities of extrusion aid material sufficient to allow compatible degrees of flowability; 2) arranging the two compositions in a preform so that the composition forming the outer wall is disposed in a coaxial arrangement about the composition forming the inner wall; 3) extruding the preform under pressure; 4) heating the extruded article to a temperature sufficient to volatilize off substantially all of the extrusion aid material; and 5) sintering the extruded article in a second oven to a temperature above the melt

temperature of the compositions.

Polymers suitable for use according to the present invention include fluorocarbon polymers which are capable of being combined with organic and inorganic fillers and formable into multi-wall articles which exhibit the combined properties of enhanced abrasion, crush and creep resistance. A particularly preferred fluorocarbon polymer comprises PTFE.

PTFE polymers useful in the practice of the present invention may comprise PTFE homopolymer, although it is contemplated that the PTFE polymer will preferably comprise a copolymer of tetrafluoroethylene monomer ("TFE") with other halocarbon monomers such as, for example, chlorotrifluoroethylene ("CTFE"), hexafluoropropylene ("HFP") or perfluoropropylvinyl ether ("PPVE"). Preferably, the PTFE polymer will comprise a copolymer of TFE and CTFE. Accordingly, it should be understood that use herein of the term fluorocarbon shall include both fluorocarbon homopolymers as well as copolymers of fluorocarbons and other halocarbons.

The PTFE polymers suitable for use in the articles of the present invention include conventional PTFE polymers obtained by conventional means, for example, by the polymerization of TFE under pressure using free radical catalysts such as peroxides or persulfates. PTFE produced by other means is also considered suitable for use provided that the PTFE resin produced by such means is capable of being combined with fillers to form articles which display enhanced abrasion, crush and creep resistance.

While the use of granular PTFE, or a blend of granular and a

coagulated dispersion resin PTFE is considered to be within the scope of the present invention, it is contemplated that the use of a coagulated dispersion resin PTFE is preferred as such resins are more amenable to extrusion. The preference for a coagulated dispersion resin PTFE in such embodiments is also driven by the processing requirements of paste extrusion. As is known to the art, paste extrusion involves a packing step in which material is arranged in a mold often referred to as a preform. In accordance with the known packing characteristics of PTFE, the use of a coagulated dispersion resin achieves more readily a uniform and complete distribution of filler material within the mold thereby minimizing the creation of voids. The use of a coagulated dispersion resin in paste extrusion processes also yields a superior extruded product in which the PTFE particles comprising the mold are transformed into a tightly knit matrix of elongated strand-like particles.

Techniques for the production of coagulated dispersion PTFE resins are well known, and the use of PTFE resins produced by any of these techniques is well within the scope of this invention. For example, coagulated dispersion PTFE resins may be produced by coagulating colloidal PTFE particles as disclosed more fully in U.S. Patent No. 4,451,616, which is incorporated herein by reference.

The Inner Wall Component

In certain preferred embodiments, the articles of the present

invention will comprise a conduit having two relatively discreet, coaxially arranged walls. As used hereinafter, these two coaxially arranged walls will be referred to as the inner wall and the outer wall, respectively. In certain other preferred embodiments, the articles of the present invention will further comprise a third, relatively discreet, coaxially arranged wall disposed between the inner wall and the outer wall.

In all embodiments which comprise at least an inner wall and an outer wall, the material comprising the inner wall component preferably comprises a fluorocarbon polymer, even more preferably PTFE, and even more preferably coagulated dispersion resin PTFE. While PTFE has a relatively high frictional efficiency, pure PTFE has heretofore been impractical as a material for use in direct contact with the repetitive movements of cables in motion transmitting cable assemblies due to its limited abrasion resistance as described above. In certain embodiments of the present invention, pure PTFE is a preferred material for the inner wall component due to the presence of, and role played by, the inorganically filled outer wall component. Due to the multi-wall configuration, the outer wall component of the articles of the present invention provides a firm backing to the inner wall component and permits the inner wall to be composed of pure PTFE without an unacceptable loss in abrasion resistance.

In certain embodiments, the inner wall component further comprises an organic filler. The inclusion of such a filler material in the inner wall component further enhances abrasion and

creep resistance. In such embodiments, the organic fillers suitable for use in the articles of the present invention may be any of a wide variety of high temperature organic compounds including aromatic polyesters, thermoplastic or thermosetting polyamide, polyimide, and polyamide imide resins, polyetherimides, polyether ketones, polyether ether ketones, polysufones, polyether sulfones, polyphenylene sulfones, polyphenylene sulfides, polysulfide imides, and the like.

The amount of organic filler added will vary with, among other things, the filler material used and the desired performance characteristics of the resultant conduit. The organic filler should nonetheless be present in sufficient concentrations to attain a resulting composite capable of relatively high frictional efficiency over extended periods of use and under various load conditions. Generally, the organic fillers are preferably present in amounts from about 2 to about 40 percent by weight of the composite, and even more preferably from about ~~10~~ 5 to about 25 percent by weight.

Cpm 4/23/98
KDX 4/23/98
KAR 4/23/98

The Outer Wall Component

The material comprising the outer wall component preferably comprises a fluorocarbon polymer, even more preferably PTFE, and even more preferably coagulated dispersion resin PTFE. Such polymers are preferred for use in the outer wall component of the present invention as they are capable of being filled with any of a wide variety of inorganic filler materials to form a relatively

hard outer wall of a multi-wall article having enhanced tensile strength and crush resistance.

The inorganic filler suitable for use in the present invention may comprise a wide variety of inorganic materials including carbon fibers, carbon powder, graphite, coke flour, amorphous glass, glass fibers, glass spheres, milled glass, bronze, iron powder, iron oxide, silicon dioxide, boric oxide, zirconium oxide, and molybdenum disulfide and the like.

The inorganic filler is incorporated into the fluoropolymer resin in amounts sufficient to impart the desired improvement in physical properties. For most contemplated inorganic fillers, the filler component of the outer wall composition will be present in concentrations from about 5 to about 90 percent by weight of the composite, and more preferably from about 10 to about 40 percent by weight. Moreover, due to the provision of an inner wall as described above, lubricants can be used advantageously within the resulting conduit articles to further enhance the frictional efficiency thereof without the risk of creating an abrasive slurry with the inorganic filler material as is typically found in single walled, inorganically filled fluorocarbon polymer articles of the prior art.

The Multi-Wall Article

The combination of an abrasion resistant inner wall comprising a fluorocarbon polymer resin with a crush resistant, relatively hard outer wall comprising a fluorocarbon polymer resin and an

inorganic filler provides the multi-wall article of the present invention. In certain preferred embodiments, the multi-wall article further comprises a third wall comprising a fluorocarbon polymer resin disposed between the inner wall and the outer wall. Insofar as organic fillers suitable for use in the present invention are, as a general matter, significantly more expensive per unit weight than similarly suitable inorganic fillers, significant cost savings can be realized in the construction of articles which do not contain organic fillers or which minimize the amounts required by having the outer wall component comprise the major compositional percentage of the article so formed.

In certain embodiments, it will be desirable to maximize the percentage of the thickness of the dual wall article comprising the outer wall composite in order to produce a firmer backing for the inner wall as well as to provide greater crush resistance. In applications in which significant internal abrasive forces are imparted, such as high load applications, the inner wall component will preferably comprise a combination of fluorocarbon polymer resin and an organic filler, and may also comprise up to about 50% of the overall thickness of the multi wall-article in order to ensure adequate abrasion resistance. Thus, while the relative thicknesses of the inner and the outer walls will be determined by, and will vary in accordance with, among other things, the applications for which the articles are intended, it is contemplated that the thickness of the inner wall will preferably comprise from about 5 to about 50%, and even more preferably from

about 10 to about 25%, of the total thickness of the articles so formed. Correspondingly, the thickness of the outer wall will preferably comprise from about 50 to about 95%, and even more preferably from about 75 to about 90%, of the total thickness thereof.

EXAMPLE 1

55 pounds of neat coagulated dispersion resin PTFE, 13.75 pounds of polyphenylene sulfide powder, and 14.08 pounds of an isoparaffinic extrusion aid solvent sold under the trade name ISOPAR G by Exxon USA is charged to a Patterson-Kelley Liquids-Solids blender and mixed for ten minutes. The resultant mixture is designated Composition A. Separately from Composition A, 55 pounds of neat coagulated dispersion resin PTFE, 9.71 pounds of solid glass spheres and 13.25 pounds of ISOPAR G is charged to a Patterson-Kelley Liquids-Solids blender and mixed for ten minutes. The resultant mixture is designated Composition B.

Composition A is placed into the inner compartment of a two-part mold configured in a generally cylindrical shape having concentrically arranged inner and outer cylindrical portions. Composition B is placed in the outer compartment of the mold so that Composition B is disposed about Composition A. The walls of the inner compartment are spaced to define a distance of about 35 mm., and the walls of the outer compartment are spaced to define a distance of about 63 mm. The inner compartment of the mold is then removed placing the Composition B in direct contact with and

completely surrounding Composition A. The combination of Composition A and Composition B are longitudinally compressed simultaneously at about 300 psi to form a preform.

An extrusion cylinder of a Jennings ram extruder having a 108 inch stroke and a 3.5 inch diameter is loaded with a preform which is then paste extruded at room temperature with the extrusion die heated to 200°F. The extruded article is then heated in a first oven to 380°F for one minute in order to volatilize off substantially all of the extrusion aid material. The article is then heated in a second oven to 700°F for one minute in order to sinter the extruded article and complete the formation of the bonds within and between the inner and outer walls thereof. The sintered, dual-wall article thus formed comprises an inner wall of 20% of the overall thickness of the conduit and an outer wall of 80% of the overall thickness of the conduit.

EXAMPLE 2

A high-load ambient S-test was performed on the sintered dual wall article produced in accordance with Example 1 to demonstrate the improved abrasion resistance thereof. This test was conducted using a tubular conduit having a 7 x 7 stranded stainless steel wire guided therethrough routed over an "S" shaped fixture wherein the curvilinear portions define inner radii of 4 inches and subtends angles of 120 degrees in accordance with General Motors standard CMP-TF004. The wire is then actuated by a motor to cause

a repetitive reciprocal movement of 1.5 inches relative to the tubular conduit at a frequency of 60 cycles per minute. Abrasion resistance was then measured after the completion of 500,000 S-test cycles by weighing the conduit, after cleaning with isopropyl alcohol and allowing to dry, and comparing measured weight with the weight of the conduit prior to testing. The conduit was found to have a weight gain of 10 milligrams after testing. In addition, the conduit was also found to have a frictional efficiency of 90% after completion of 500,000 test cycles as measured in accordance with General Motors standard CMP-TF004.

CLAIMS

What is claimed is:

1. An abrasion resistant tubular article comprising an inner wall and an outer wall disposed therearound wherein the inner wall comprises polytetrafluoroethylene, and wherein the outer wall comprises polytetrafluoroethylene and an inorganic filler.

2. The article of claim 1 wherein the outer wall comprises from about 10 to about 95 wt.% polytetrafluoroethylene and from about 5 to about 90 wt.% inorganic filler.

3. The article of claim 1 wherein the outer wall comprises from about 60 to about 90 wt.% polytetrafluoroethylene and from about 10 to about 40 wt.% inorganic filler.

4. The article of claim 1 wherein the inner wall further comprises an organic filler.

5. The article cf claim 4 wherein the inner wall comprises from about 60 to about 98 wt.% polytetrafluoroethylene and from about 2 to about 40 wt.% organic filler.

6. The article of claim 4 wherein the inner wall comprises from about 75 to about 95 wt.% polytetrafluoroethylene and from about ~~10~~ 5 to about 25 wt.% organic filler.

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7. The article of claim 1 wherein the inorganic filler is selected from the group consisting of carbon fibers, carbon powder, graphite, coke flour, amorphous glass, glass fibers, glass spheres, milled glass, bronze, iron powder, iron oxide, silicon dioxide, boric oxide, zirconium oxide, and molybdenum disulfide and combinations of two or more of these.

8. The article of claim 4 wherein the organic filler is selected from the group consisting of aromatic polyesters, thermoplastic or thermosetting polyamide, polyimide, and polyamide imide resins, polyetherimides, polyether ketones, polyether ether ketones, polysufones, polyether sulfones, polyphenylene sulfones, polyphenylene sulfides, polysulfide imides and combinations of two or more of these.

9. The article of claim 1 wherein the inner wall comprises from about 5 to about 50% of the total thickness thereof.

10. The article of claim 1 wherein the inner wall comprises from about 10 to about 25% of the total thickness thereof.

11. The article of claim 4 further comprising a layer of polytetrafluoroethylene disposed between the inner wall and the outer wall thereof.

12. An abrasion resistant tubular article comprising an inner

wall and an outer wall disposed therearound wherein the inner wall comprises from about 75 to about 90 wt.% polytetrafluoroethylene and from about ~~10~~ 5 to about 25 wt.% organic filler, and wherein the outer wall comprises from about 60 to about 90 wt.% polytetrafluoroethylene and from about ~~10~~ 10 to about 40 wt.% inorganic filler.

13. The article of claim 12 wherein the inorganic filler is selected from the group consisting of carbon fibers, carbon powder, graphite, coke flour, amorphous glass, glass fibers, glass spheres, milled glass, bronze, iron powder, iron oxide, silicon dioxide, boric oxide, zirconium oxide, and molybdenum disulfide and combinations of two or more of these.

14. The article of claim 12 wherein the organic filler is selected from the group consisting of aromatic polyesters, thermoplastic or thermosetting polyamide, polyimide, and polyamide imide resins, polyetherimides, polyether ketones, polyether ether ketones, polysufones, polyether sulfones, polyphenylene sulfones, polyphenylene sulfides, polysulfide imides and combinations of two or more of these.

15. The article of claim 12 wherein the inner wall comprises from about 5 to about 50% of the total thickness thereof.

16. The article of claim 12 wherein the inner wall comprises from about 10 to about 25% of the total thickness thereof.

17. The article of claim 12 further comprising a layer of polytetrafluoroethylene disposed between the inner wall and the outer wall thereof.

18. A method of making an abrasion resistant multi-wall tubular article comprising the steps of:

premixing a first composition of polytetrafluoroethylene, an inorganic filler, and an extrusion aid material;

premixing a second composition of polytetrafluoroethylene and an extrusion aid material;

arranging the first composition and the second composition in a preform so that the first composition is disposed in a coaxial arrangement about the second composition;

ram extruding the preform under pressure to form an extruded article; and

heating the extruded article in an oven to a temperature above the melt temperature of the extruded article.

19. The method of claim 18 wherein the second composition further comprises an organic filler.

20. The method of claim 19 wherein the arranging step further comprises the disposition of a third composition comprising polytetrafluoroethylene and an extrusion aid material in a coaxial arrangement between the first composition and the second composition in the preform.

21. The method of claim 18 further comprising the step of heating the extruded article to a temperature sufficient to volatilize off substantially all of the extrusion aid material said step occurring prior to heating the extruded article to a temperature above the melt temperature of the extruded article.

22. The method of claim 21 wherein the second composition further comprises an organic filler.

23. The method of claim 22 wherein the arranging step further comprises the disposition of a third composition comprising polytetrafluoroethylene and an extrusion aid material in a coaxial arrangement between the first composition and the second composition in the preform.

ABSTRACT

An abrasion-resistant multi-wall tubular article and a method of making same. The tubular article comprises an inner wall of polytetrafluoroethylene and an outer wall of polytetrafluoroethylene and an inorganic filler. The article of the present invention has a high internal frictional efficiency over wide temperature and load conditions as well as enhanced external crush and creep resistance and is particularly well adapted for use in motion transmitting cable assemblies and the like.

Docket No.
21669 USA

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ABRASION RESISTANT MULTI-WALL ARTICLE AND METHOD OF MAKING SAME

the specification of which

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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